WHAT IS CLAIMED IS:

1. A crystallization apparatus, which includes an illumination system that illuminates a phase shift mask to irradiate a polycrystalline semiconductor film or an amorphous semiconductor film with a light beam that has a light intensity distribution of an inverse peak pattern that has a minimum light intensity in an area corresponding to a phase shift portion of the phase shift mask to produce a crystallized semiconductor film, comprising:

an optical member to form on a predetermined plane a light intensity distribution of a concave pattern, which has a light intensity that is minimum in an area corresponding to the phase shift portion and increases toward the circumference of that area based on the light from the illumination system; and

an image-forming optical system to set a surface of the polycrystalline semiconductor film or the amorphous semiconductor film or its conjugate plane and the predetermined plane to an optical conjugate relationship.

2. The crystallization apparatus according to claim 1, wherein the optical member has a transmission type amplitude modulation mask having a transmittance distribution according to the light intensity distribution having the concave pattern to be formed on the predetermined plane.

3. The crystallization apparatus according to claim 2, wherein the transmission type amplitude modulation mask has a light transmission portion having a fixed thickness, and a light absorption portion having a thickness distribution according to the light intensity distribution having the concave pattern to be formed on the predetermined plane.

4. The crystallization apparatus according to claim 3, wherein the light absorption portion has a sinusoidal surface.

5. The crystallization apparatus according to claim 4, wherein the sinusoidal surface is formed into a continuously curved shape or a step-like shape.

6. The crystallization apparatus according to claim 1, wherein the optical member is an open type amplitude modulation mask having a numerical aperture distribution according to the light intensity distribution having the concave pattern to be formed on the predetermined plane.

7. The crystallization apparatus according to claim 6, wherein the open type amplitude modulation mask has many minute transmission areas or many minute light shielding areas or both.

8. The crystallization apparatus according to claim 7, wherein sizes of the minute transmission area and the minute light shielding area are set to be substantially smaller than a resolution of the

image-forming optical system.

9. The crystallization apparatus according to claim 8, wherein the image-forming optical system is a reduction optical system.

10. The crystallization apparatus according to claim 1, wherein, on the predetermined plane, the optical member is a converging/diverging element that produces an area that is illuminated with a part of the light beam is diverged in accordance with the phase shift portion and an area that is illuminated with a part of the light beam is converged in accordance with the circumference of the phase shift portion.

11. The crystallization apparatus according to claim 10, wherein the converging/diverging element has a diverging refraction surface to diverge a part of the light beam and a converging refraction surface to converge a part of the light beam.

12. The crystallization apparatus according to claim 11, wherein the diverging refraction surface and the converging refraction surface form a sinusoidal refraction surface.

13. The crystallization apparatus according to claim 12, wherein the sinusoidal refraction surface is formed into a continuous curved shape or a step-like shape.

14. The crystallization apparatus according to claim 1, wherein the optical member comprises a light

intensity distribution formation element to form a predetermined light intensity distribution having a light intensity that is larger at the circumference rather than a center on a pupil plane of the illumination system or in the vicinity thereof, and a wavefront splitting element to wavefront-split a light beam supplied from the illumination system into a plurality of light beams and converge each wavefront-split light beam in an area corresponding to the phase shift portion on the predetermined plane.

15. The crystallization apparatus according to claim 14, wherein the wavefront splitting element has a plurality of optical elements having a converging function.

16. The crystallization apparatus according to claim 14 or claim 15, wherein the predetermined light intensity distribution has a circular central area, which has a relatively small light intensity, and a toric peripheral area, which is formed so as to surround the central area and has a relatively large light intensity.

17. The crystallization apparatus according to claim 14 or claim 15, wherein the predetermined light intensity distribution has a central area, which is elongated along a predetermined direction and has a relatively small light intensity, and a peripheral area, which is formed so as to surround or sandwich the

central area and has a relatively large light intensity.

18. The crystallization apparatus according to claim 14, wherein the light intensity distribution formation element has a transmission filter having a predetermined light transmittance distribution, which is arranged on the illumination pupil plane or in the vicinity thereof.

19. The crystallization apparatus according to claim 1, wherein a phase shift surface of the phase shift mask is formed on a surface on a side opposite to the illumination system side.

20. The crystallization apparatus according to claim 1, wherein the light intensity distribution that is applied to the polycrystalline semiconductor film or the amorphous semiconductor film has an inverse peak pattern area that has a minimum light intensity in an area corresponding to the phase shift portion of the phase shift mask, and a concave pattern area, which has the light intensity increases from the inverse peak pattern area toward the circumference, and has an inflection point where an inclination decreases toward the circumference between the inverse peak pattern area and the concave pattern area.

21. The crystallization apparatus according to claim 1, wherein the polycrystalline semiconductor film or the amorphous semiconductor film and the phase shift

mask are arranged parallel to each other and in close proximity to each other.

22. The crystallization apparatus according to claim 1, further comprising a second image-forming optical system arranged in a light path between the polycrystalline semiconductor film or the amorphous semiconductor film and the phase shift mask,

wherein a surface of the polycrystalline semiconductor film or the amorphous semiconductor film is set apart from a plane that is optically conjugate with the phase shift mask through the second image-forming optical system along an optical axis by a predetermined distance.

23. The crystallization apparatus according to claim 1, further comprising a second image-forming optical system arranged in a light path between the polycrystalline semiconductor film or the amorphous semiconductor film and the phase shift mask,

wherein a surface of the polycrystalline semiconductor film or the amorphous semiconductor film is set to a plane optically conjugate with the phase shift mask through the second image-forming optical system, and

an image side numerical aperture of the second image-forming optical system is set to a value required to generate the light intensity distribution having the inverse peak pattern.

24. A crystallization method, which illuminates a phase shift mask to irradiate a polycrystalline semiconductor film or an amorphous semiconductor film with a light beam that has a light intensity distribution of an inverse peak pattern, which has a light intensity that is minimum in an area corresponding to a phase shift portion of the phase shift mask to produce a crystallized semiconductor film, comprising:

forming on a predetermined plane a light intensity distribution having a concave pattern that has a light intensity that becomes minimum in an area corresponding to the phase shift portion and increases toward the circumference of that area based on the light from the illumination system; and

setting a surface of the polycrystalline semiconductor film or the amorphous semiconductor film or its conjugate plane and the predetermined plane to an optically conjugate relationship through the image-forming optical system.

25. The crystallization method according to claim 24, wherein the polycrystalline semiconductor film or the amorphous semiconductor film and the phase shift mask are arranged parallel to each other and in close proximity to each other.

26. The crystallization method according to claim 24, wherein a second image-forming optical system

is arranged in a light path between the polycrystalline semiconductor film or the amorphous semiconductor film and the phase shift mask, and

a surface of the polycrystalline semiconductor film or the amorphous semiconductor film is set apart from a plane that is optically conjugate with the phase shift mask along an optical axis by a predetermined distance.

27. The crystallization method according to claim 24, wherein a second image-forming optical system is arranged in a light path between the polycrystalline semiconductor film or the amorphous semiconductor film and the phase shift mask,

an image side numerical aperture of the second image-forming optical system is set to a value required to generate the light intensity distribution having the inverse peak pattern, and

the surface of the polycrystalline semiconductor film or the amorphous semiconductor film is set to a plane that is optically conjugate with the phase shift mask through the second image-forming optical system.

28. A thin film transistor manufactured by the crystallization method according to claim 24.

29. A display apparatus including the thin film transistor according to claim 28.

30. A crystallization apparatus, which includes an illumination system that illuminates a phase shift mask

to irradiate a polycrystalline semiconductor film or an amorphous semiconductor film with a light beam that has a light intensity distribution of an inverse peak pattern that has a minimum light intensity in an area corresponding to a phase shift portion of the phase shift mask to produce a crystallized semiconductor film, comprising:

an optical member to form on a predetermined plane a light intensity distribution of a concave pattern, which has a light intensity that is minimum at the center and increases toward the circumference based on the light from the illumination system; and

an image-forming optical system to set a surface of the polycrystalline semiconductor film or the amorphous semiconductor film or its conjugate plane and the predetermined plane to an optical conjugate relationship.

31. A crystallization method, which illuminates a phase shift mask to irradiate a polycrystalline semiconductor film or an amorphous semiconductor film with a light beam that has a light intensity distribution of an inverse peak pattern, which has a light intensity that is minimum in an area corresponding to a phase shift portion of the phase shift mask to produce a crystallized semiconductor film, comprising:

forming on a predetermined plane a light intensity

distribution having a concave pattern that has a light intensity that is minimum at the center and increases toward the circumference based on the light from the illumination system; and

setting a surface of the polycrystalline semiconductor film or the amorphous semiconductor film or its conjugate plane and the predetermined plane to an optically conjugate relationship through the image-forming optical system.